Before the
Federal Communications Commission
Washington, D.C.

In the matter of:

	)	
Revitalization of the AM Radio Service	**)**	**MB Docket No. 13-249**
	)	

REPLY COMMENTS OF KINTRONIC LABORATORIES, INC.

The domestic and international broadcast radio engineering, design, and manufacturing firm of Kintronic Laboratories, Inc. ("KTL") hereby submits these Reply Comments in response to the Commission's Notice of Proposed Rulemaking (NPRM), dated October 31, 2013, in the above-captioned proceeding. In that Notice, the Commission solicited comments on its various specific proposals to revitalize AM radio and also invited submission of further proposals.

OVERVIEW. We have reviewed the Notice and we wholeheartedly support the Commission's goal of revitalizing the AM radio service. AM radio constitutes the most bandwidth-efficient broadcast medium and provides an essential service to many Americans, particularly in rural and remote areas, and those traveling in the vast expanses of this nation. We strongly concur with Commissioner Pai's efforts to champion this thrust, and with Commissioner Clyburn's recognition that AM provides a unique venue to facilitate female and minority media management and ownership, as well as to provide vital programming diversity for the American public, particularly in niche markets and demographics. AM radio, due to its generally lower capital requirements, can also provide a realistic setting for family-based, community-focused station programming and ownership, especially in smaller localities. AM radio is truly a national resource, a source of unique voices, and one that we can ill afford to abandon, particularly in light of its unique propagation characteristics and tremendous reach, especially in times of local, regional, and even national emergencies***. Truly, this action has the rare potential of conserving a unique national resource.***

Fundamentally, as we see it, the two greatest issues currently threatening AM radio are: **(1)** the worsening electromagnetic environment; and **(2)** the concurrent failure of the consumer-products industry to provide the listening public with high-quality AM receiver systems (comparable to their FM counterparts), particularly in the areas of sensitivity, selectivity, noise rejection, and audio bandwidth. Actually, these two effects are closely interrelated, since the steadily increasing noise floor in the AM band has materially contributed to the unfortunate trend to reduce AM receiver bandwidths even further than those typical in the 1960s and '70s. It has been all too easy for the receiver manufacturers to simply reduce overall receiver bandwidths down to even 2-3 kHz (sometimes worse than telephone grade!) to address the pervasive issues of electromagnetic interference (EMI) noise from power lines, fluorescent-lamp ballasts, personal computers, consumer devices, and the like, not to mention broadband static impulses from lightning and increased adjacent-channel and alternate-channel interference from more recently allocated AM stations. Another factor in the lack of receiver bandwidth was the inability of radio manufacturers to obtain decently matched varactor diodes on a production basis to provide the required tracking accuracy for the simultaneous electronic tuning of the AM RF front-end, mixer, and local-oscillator stages in their radio receivers (both home *and* auto). Added on top of all this is the progressive trend in the automobile industry to replace metal body parts with plastic (which worsens EMI shielding), adapt windshield-type antennas (which provide markedly poorer reception performance for both AM and even FM), and add a multitude of noise-generating microcomputers for engine control, antiskid braking systems, and the like. The net result has been AM radios with very low audio and reception quality.

It is therefore imperative to the sustainability of AM radio that the Commission strongly encourage (or even <u>mandate</u>) significant improvement in consumer AM receiver systems. Without this, the American listening public will continue to regard AM as a noisy, low-fidelity medium and will consequently tune out. In this NPRM the Commission is, we believe, very wisely considering several major technical improvements to the AM stations' transmitting system and allocation requirements, ***but without advanced consumer-receiver features to address the severe noise, interference, and bandwidth challenges to good, clean AM-band reception, the appeal of AM to the public will inevitably be lost***.

The technical goals of vastly-improved consumer AM receivers are actually near at hand. ***The great majority of the required receiver functions are already offered*** by international chip manufacturers such as Silicon Labs (Austin, TX), NXP Semiconductor (Netherlands), ST Microelectronics (Switzerland), and Frontier Silicon (U.K.) in their advanced software-defined radio (SDR) AM/FM chip products (e.g., agile, programmable channel bandwidths and audio high-cut filters [to address the increased levels of nighttime and critical-hours skywave adjacent-channel interference (ACI)], noise limiters, and adaptive RF/IF AGC functions). A few U.S.-specific enhancements such as adaptive notch filters at 10 kHz could be easily added. Actually, advanced, highly effective RF noise limiting/audio blanking functions [long known to military and amateur radio operators] were initially developed by Motorola for the AM consumer radio market within later-model CQUAM stereo AMAX-compatible chipsets in 1996 (specifically the MC13027/MC13122 combo). These chips were actually produced for the consumer market, but due to the decline in AM popularity in that era did not get major use. It should also be noted that the Motorola CQUAM chips supported adaptive-bandwidth 10-kHz notch filters to deal with ACI, driven from special analog on-chip detectors. Thus, these high-performance receiver features are hardly new, but in modern chips can be offered now with a far lower off-chip parts count and less overall cost to the consumer.

We fully appreciate the Commission's leadership role in the overall thrust to improve AM radio, beginning in the 1989-1991 period. It is our view that the Commission in large measure did its job well, i.e., the establishment of wider-bandwidth, consistent AM transmitter performance, the reduction of mutual broadcast interference, and the encouragement of the production of better receiver hardware by the consumer-electronics industry. Initially the consumer manufacturers, though perhaps still stung by the costly AM stereo debacle of the 1980s, made a concerted attempt to codify performance of AM receivers through the 1993 AMAX standard, a joint effort of the EIA (Electronic Industries Association) and the NAB (National Association of Broadcasters), with Commission backing. In that standard, the desirability for higher receiver bandwidths and noise performance was broadly acknowledged, with the purpose to restore the reception of high-quality AM signals to the public. An AMAX-certified receiver had at least 7.5-kHz bandwidth for home and auto versions, and 6.5-kHz for portables, plus some form of bandwidth control, either automatic or at least two manual settings (e.g., “narrow” and “wide”). It also had to meet NRSC receiver standards for distortion and deemphasis, provisions for an external antenna, coverage of the Expanded AM band, and finally, effective noise blanking. The Commission rapidly followed up on this with codification of the

CQUAM AM stereo standard, also in 1993. At this point, the stage appeared to be set for rejuvenation of the AM band; nevertheless, with the legacy of confusion and disappointment in the rollout of the multiple incompatible AM stereo systems, and failure of the manufacturers (including the auto makers) to effectively promote AMAX radios, coupled with the ever-increasing background of noise in the band, the public soon lost interest and moved on to other media.

It appears at this point, the Commission has a fundamental choice for AM radio: either take a firm hand in pushing new, improved receiver technology implementations, or passively permit AM to spiral downward into a slow, painful death, which is clearly ***not*** in the public interest. The legal precedent for the former is quite strong. In the early 1960s, the UHF television band was close to economic extinction, as very few TV receivers were equipped with UHF tuners. As a result, the **All-Channel Receiver Act** of 1962 [47 U.S.C. § 303(s)] was passed by the United States Congress in 1961, to allow the Commission to require that all television set manufacturers must include UHF tuners, so that new UHF-band TV stations (then Channels 14 to 83) could be received by the public. This was a problem at the time since the major TV networks were well-established on VHF, while many local-only stations on UHF were struggling for survival. Specifically, the Act provided that the Commission would "have authority to require that apparatus designed to receive television pictures broadcast simultaneously with sound be capable of adequately receiving all frequencies allocated by the Commission for television broadcasting." Under authority provided by the All-Channel Receiver Act, the Commission also adopted a number of technical standards to increase parity between the UHF and VHF television services, including a 14-dB maximum UHF noise figure for television receivers. (*If this mandate had not been accomplished back then, where would DTV be today?*) In the 1980s, this same law was apparently used as precedent to require that all AM receivers be able to pick up the new Expanded-Band stations from 1610 to 1700 kHz. This requirement was enacted in advance of new stations being allotted in the 1990s [1].

Since in the early 1960s the Commission and Congress were unwilling to permit UHF television to flounder, it would seem logical that due to the huge receiver disparity, AM radio is now in a similar situation, which must be remedied very soon. The fundamental solutions for AM are strikingly similar to those of UHF-TV; ***receiver parity with the dominant band (FM) must be established to enable the public to make listening choices on a more level playing***

field. The relevant technical receiver standards to achieve effective parity include: **(1)** low internal noise floor; **(2)** high overall RF sensitivity, selectivity, and dynamic range; **(3)** highly effective noise (EMI) rejection**; (4)** full 10-kHz audio bandwidth capability with low distortion; and **(5)** stereo capability [if on FM, then on AM]. Without the first three items, basic reception will suffer (this includes associated antennas); without the last two, the sound cannot be competitive with FM.

The original UHF tuner improvements mandated by the All-Channel Receiver Act represented a relatively small cost increment for the TV sets of the day; similarly, with modern high-volume chip technology, the needed signal-processing features for the AM-side of modern receivers can be added for about $1-2 at most (much different than in the AMAX days). Since virtually all existing radios have AM now (except for a few cell-phone type units), the issue is essentially that of bringing chip AM performance (and audio response) up to equate with FM. Clearly, automobiles are the prime venue; home hi-fi systems and portables will undoubtedly follow. Further, it would seem logical that all HD radios also be upgraded on analog AM; with the greater processing complexity of these premium units, the additional cost on a per-unit basis to augment them would be negligible. If Congressional action is actually deemed necessary to enable all the requisite steps in AM revitalization to occur, it is encouraging to remember that the CALM Act was very recently passed to address a far less significant public issue.

Based on experience from the 63-year history of our firm and its predecessor providing engineering consulting and product services to the licensees of U.S. AM radio stations as well as many international broadcasters, we intend with these comments to provide focused analyses of the Commission’s specific proposals related to AM transmission standards and also add to the discussion with further proposals we believe to be essential for AM revitalization. Our comments will focus on several over-arching needs for AM radio, plus specific rule changes that can be used by AM stations in general to improve their flexibility in developing technical facilities to improve their coverage in the existing AM band. We believe that the Commission's stated goal of truly revitalizing the AM broadcasting service can only be achieved by a concerted, multi-faceted approach to this complex technical, economic, and policy challenge. Ultimately, the American listening public will be the real beneficiary of these changes.

<u>REPLY COMMENTS</u>. In the following Reply Comments, we emphasize our strong general agreement with the broadcast engineering community, and in particular, the earlier cogent Comments from du Treil, Lundin & Rackley, Inc. ("dLR"), Sellmeyer Engineering ("Sellmeyer"), and Hatfield & Dawson ("H&D"), on the six specific Proposals offered by the Commission in the NPRM, as well as several useful Further Proposals. We also add a few specific comments which may differ somewhat from those earlier perspectives but which provide some additional thoughts for consideration by the Commission.

<u>Commission Proposal A</u> – Open FM Translator Filing Window Exclusively for AM Licensees and Permittees

We recognize, along the lines of earlier NPRM Comments from dLR, Sellmeyer, and H&D, that FM translators may well afford short-term economic assistance to existing AM stations that are able to use them to provide service to the public, and we support the Commission's facilitation of that with the proposed filing window, but we likewise do not see FM translators as more than a stop-gap solution to revitalization of the AM radio service. The acute lack of FM frequency availability will appreciably limit the extent to which AM stations are able to utilize FM translators, particularly in and near larger radio markets. Unfortunately, the widespread use of FM translators will in the short run only serve to speed the exodus by AM listeners to the superior FM band and thus will ultimately work against both AM broadcasters and the overall public interest.

<u>Commission Proposal B</u> – Modify Daytime Community Coverage Standards for Existing AM Stations

We believe, in concurrence with dLR, Sellmeyer, H&D, and other commenters, that the community-coverage requirement should be eliminated altogether, or at least greatly relaxed, to provide increased flexibility for stations whose population centers have shifted or those who seek to serve specific demographics (e.g., minority communities). With many AM stations now providing a very small segment of the electronically-delivered audio content available to the public, from an increasingly diverse number of over-the-air sources, additional administrative relief is justified to allow them the freedom to permit normal business forces to guide them in how to best serve their actual audiences in a sustainable manner.

Commission Proposal C – Modify Nighttime Community Coverage Standards for Existing AM Stations

See the above answer for Commission Proposal B.

Commission Proposal D – Eliminate the AM "Ratchet Rule"

We fully support the prompt deletion of the AM "Ratchet Rule". This action has in practice failed to provide meaningful improvements in nighttime station-to-station interference levels, has induced undesirable engineering complications as well as unjustified loss of coverage for the facility being modified, and has in general become an unnecessary encumbrance to the alteration of nighttime facilities. We therefore judge that its continuance is not in the public interest.

Commission Proposal E – Permit Wider Implementation of Modulation Dependent Carrier Level Control Technologies

We favor allowing AM broadcasters to have maximum practical flexibility in minimizing transmission power costs. We therefore generally support wider implementation of modulation-dependent carrier-level control technologies (MDCL), but subject to a few common-sense constraints. Using any of the several types of MDCL techniques already demonstrated, there are two major caveats; first, at high modulation levels, the full carrier-to-sideband amplitude ratio must be always maintained (at least on peaks) to avoid significant distortion and splatter due to even transient negative overmodulation. Virtually all existing AM receivers (which employ envelope detectors with syllabic-rate or even slower AGC action) will otherwise distort the recovered audio, often badly. The original DDC (Dynamic Carrier Control) technique reduces the carrier only under low-modulation conditions but will concurrently induce noise-modulation during programming pauses in envelope-detector receivers (essentially all of them). In contrast, the BBC-pioneered AMC (Amplitude Modulation Companding) maintains full carrier during pauses and reduces the carrier along with the sidebands at high modulation levels; thus effectively compressing the transmitted output at high levels. This method avoids AGC-induced noise modulation for weak signals in the receiver during low-modulation intervals and actually on average benignly reduces the peak transmitted RF power. Nautel, Ltd. has also demonstrated a successful blend of the two basic techniques, called DAM (Dynamic Amplitude Modulation), which reduces carrier power chiefly at intermediate modulation levels. At this juncture, we see that any of these techniques should be adequate for voice programming, but more caution should be exercised with music. Further, the more heavily processed the program audio, the less benefit MDCL will yield. Obviously, the Commission will have to address the consequent technical issues with modulation monitors, transmitter IPM, RF antenna-current and field-strength measurements, and overall spectral emission compliance. An additional potential concern is the interaction with prevailing receiver AGC time constants. Nevertheless, we see no reason to delay the sanctioned implementation of MDCL methods, though we would prefer the DAM and/or AMC algorithms, which appear to be gentler overall. It is our further suggestion that with Commission acquiescence, the NAB and SBE, along with the equipment manufacturers, immediately form active working groups to conduct more in-depth studies of all the ramifications of MDCL techniques, gather data, and develop a set of "good practice" engineering guidelines to assist broadcasters to achieve useful utility-power reductions without significant signal degradation for the public. These methods are always program-dependent, so a broad sampling of formats should be included.

<u>Commission Proposal F</u> – Modify AM Antenna Efficiency Standards

We agree, with many other commenters, that minimum AM antenna efficiency requirements should be eliminated from the rules. Clearly, serving audiences well implies means being located near the listeners, but the increasingly stringent local regulation of tower construction, coupled with the decreasing availability of land to meet standard ground-system size requirements for minimum efficiency, impede finding such locations. AM stations should have much more flexibility in choosing tower height and ground system dimensions, letting normal business forces prompt the owners to seek optimum locations for serving their audiences. We especially agree with dLR that the Commission's concern should only be with the avoidance of interference to other stations – something that can be safely addressed by requiring that allocation studies be based on minimum efficiency standards where actual radiation efficiency, whether due to tower height, ground system restrictions, or both, may be expected to be lower. Further, the showing by dLR that short towers are only slightly worse than standard quarter-wave antennas in their high-angle vertical radiation characteristics should reassure that such installations can be viable even in nighttime applications. Of course, all allocation studies must include these high-angle characteristics. However, once licensed, a facility should be required to maintain proper performance levels; unmaintained, corroded antenna/ground systems only hurt broadcasters as well as the public and should not be tolerated by the Commission.

Commission Proposal Request G – Submission of Further Proposals

KTL believes that the following significant steps can also be undertaken now to encourage revitalization of the AM radio service, and we strongly encourage the Commission to take them quickly. We reiterate our agreement in principle with most of the Further Comments and Reply Comments already offered by dLR, Sellmeyer, H&D, and others in the consulting engineering community, though with some alternative suggestions. These are not at all due to any fundamental technical disagreements, but are driven by our overriding view that ***the Commission must move forcefully to enforce Part 15 Unintentional Radiator rules on Utilities and others, and further mandate major improvements in AM receiver performance, especially to achieve near-parity with FM.*** Without these key high-level actions, many of the other suggestions for improving AM service will likely become moot unless the listening public is incentivized to return to the band, via the rapid establishment of noticeably better audio and reception conditions. These Further Proposals are generally ordered in terms of overall importance to the sustainability of AM radio, with the first four being considered by far the most critical.

Further Proposal 1 – Immediately Enforce Part 15 Rules on Unintentional Radiators for Electric Utilities, Telephone, and Cable Companies and for Consumer Devices that Degrade AM Radio Reception

Very obviously, the gradual growth of EMI from electric power lines (at all voltage levels), telephone and cable lines, and a variety of consumer devices has been a tremendous detriment to AM broadcast reception. Part 15 of the Rules clearly sets reasonable limits for both

Conducted and Radiated emissions, both within the AM band and elsewhere. Although AM-band emissions are especially problematic, out-of-band radiation can also affect AM receivers, amateur radio operations, and other communications users; such illegal emissions are rightfully deemed "harmful interference" and have been universally understood as such in the communications field. The proliferation in Utilities and general industry of bad high-voltage line insulators, transformer bushings, transient protectors, and line/ground connections, not to mention BPL transmissions, has led to broadly distributed degradations in AM radio reception, particularly since in most cases power lines follow roads. Although electric utilities are the most common offenders in this regard, telephone and cable firms also have caused problems, usually due to DSL and other forms of signal leakage. Most current AM radios are quite susceptible to the impulse-type noise so created; once this raucous "buzz" even temporarily overwhelms the radio, the listener is strongly prompted to switch to FM or another programming source. The Commission must protect the public interest, along with the licensed broadcasters, by aggressively enforcing its own Regulations. Our view is that a timely Notice of Violation letter to most Utility General Managers and the like should bring a quick response; hefty fines for repeat offenders would assure more than token efforts to resolve these emission issues.

Closer to home, many existing radios and consumer devices (e.g., CD players), not to mention computers, MP3 players, and such, emit very high levels of local RFI (produced by clock circuits, RF synthesizers, microprocessors, and poor unit design) and thus impair or even preclude proximal AM radio reception. Common problems with Commission (FCC Laboratory) Type-Accepted, Verified, or Certified devices for consumers should be resolved, with some extra effort, through existing channels. Numerous internationally marketed products (from radios to fluorescent ballasts and LED drivers) with RF power-line filters for EU countries, when sold in the U.S. have filter components missing, in clear violation of Part 15 Rules. Given a few years, this major problem should eventually be soluble through concerted Commission action, particularly on resellers. As a direct result, the AM broadcast medium will be afforded some rapid and increasing relief to reception noise and coverage issues, and the public will benefit greatly from the resulting greater choice in programming and access to more diverse viewpoints.

As this effort most directly benefits AM broadcasters, it is incumbent on them to help the Commission enforce the Part 15 regulations. We heartily agree with the Comments of Kevin C. Kidd, Mark D. Humphrey, and others concerning EMI/RFI sources, and we enthusiastically support Mr. Humphrey's proposal that the Commission establish a web-based clearinghouse for Part 15-related (and also Part 73) interference complaints. We further suggest that such complaints would be open to stations and concerned individuals, who would be required to submit a detailed "e-report" of the suspected offenses. Such reports could be automatically forwarded to the Enforcement Branch and to relevant Utilities in the area (or offending stations). Appropriate website design should assure that reports are submitted by technically competent persons; in contrast, members of the general, non-technical public would be directed to complain to the local station suffering the interference.

Further Proposal 2 – Establish Minimum AM Receiver Performance Levels to Provide Parity with FM-Band Counterparts

As previously covered in the Overview section of this document, for the long-term health of the AM radio medium, it is absolutely essential that very close to full parity be established for new AM radio receivers versus their FM radio counterparts. This includes, as was cited earlier, all key AM receiver performance attributes, including: **(1)** low internal noise floor, well below the average AM-band atmospheric noise level; **(2)** high overall RF sensitivity, selectivity, and dynamic range, to provide adequate amplification of weak signals, even in the presence of significant adjacent- and/or alternate-channel signals, especially in strong-signal environments; **(3)** highly effective noise (EMI) rejection, including staged RF and IF noise blanking, accompanied by appropriate audio blanking/expansion when required**; (4)** full 10-kHz audio bandwidth capability with low detector distortion, plus dynamic bandwidth control (including adaptive 10-kHz notch filtering) as dictated by noise and adjacent-channel interference; and **(5)** stereo capability (if the receiver has FM stereo capability, it must have CQUAM decoding for AM). Without the first three requirements (this also includes the associated AM antennas), basic AM reception will suffer compared with FM; without the last two, the output sound quality cannot be closely competitive with FM (10 kHz full bandwidth on AM versus 15 kHz maximum for FM).

Several commenters have suggested a 6-kHz bandwidth for AM, largely to minimize potential ACI to next-channel stations, based on earlier data obtained during NRSC tests on typical AM receivers. Although this might be adequate for all-speech programming, for many small- and medium-market stations, who program music for significant parts of their broadcast days, the full 10 kHz is definitely needed. The line of reasoning used by the NSRC to back a 6-kHz bandwidth was largely circular in nature; the use of wider bandwidths (again, we believe 10 kHz is truly needed for music) was not preferred on average by the test listeners simply due to the high ambient channel noise levels. Actually, if the noise for these tests were processed out correctly via proper dynamic filters and blanking circuits, a greater bandwidth would have certainly been favored, since it is well known that people in general prefer wider audio bandwidths, ***but only if*** they are essentially noise-free. To eliminate all audio content above 6 kHz using the current sorry state of AM receivers as justification is to ignore the fundamental need of AM to achieve a close parity with FM sound quality to remain sustainable in the future. As mentioned previously, older receivers are so bad that such ACI concerns are probably moot, and the new, high-performance units can gracefully narrow detection bandwidth as needed in fringe-reception or high-noise scenarios. On top of all this, so poor is the AM sound of many current radios that to compensate for the overwhelming lack of treble (with a typical 2.5-kHz bandwidth), the bass is likewise reduced via low-cut filters to "balance" the sound, rendering the AM audio truly anemic (muffled *and* tinny) compared with FM (rich and full, and in stereo to boot). ***This stunning disparity cannot continue if AM is to endure***.

<u>Further Proposal 3</u> – Immediately Open Local Synchronous Booster Stations to Permanent Licenses

We emphatically support the Comments of Eng. Wifredo G. Blanco-Pi on the beneficial use of synchronous transmission by AM stations to provide coverage of isolated areas of significant population, as he cited from his experience with multiple installations on the island of Puerto Rico. The requirement to continually re-authorize synchronous boosters is an unnecessary administrative burden for both the licensees and the Commission staff. The technology of local and wide-area synchronization of dispersed transmitters via GPS and similar means has been well-proven in numerous communications venues, including television, cell-phone base stations, and even in HD radio systems; thus, the technology is well-established and there is no need to continue its "experimental" designation. We fully agree with the Reply Comments on the subject from dLR, and further strongly endorse the new Rules they have suggested for synchronous boosters. We cite these items below, with a few modifications based on our own studies:

(1) A synchronous AM system should be defined as a master, licensed standalone station with one or more synchronized, co-frequency, lower-power booster transmitters carrying identical modulation formats and time-synchronized audio signals. All boosters shall be sited within the 2 mV/m daytime contour, or 40 miles of the master transmitter's location, whichever is greater.
(2) Synchronous operation shall require absolutely synchronized carrier frequencies (also see Further Proposal 4 below). If precision offset operation is desired to minimize standing-wave fading zone effects between transmitters, this shall be accomplished via cyclic or randomized phase-shift means in the carrier reference of the booster unit(s).
(3) Synchronous systems shall consist of multiple authorized transmitters with normally protected daytime signal-level contours that overlap or are contiguous with nighttime operation, even if higher nighttime interference levels might result in disjoint interference-free contours.
(4) Nighttime-only synchronous transmitters at locations meeting the daytime criteria shall be authorized, if desired, so long as they comply with normal channel allocation Rules.
(5) Each transmitter in a synchronous system should be studied for allocations with each such transmitter considered individually.
(6) A system of synchronous transmitters, each of which meets all applicable allocations criteria with regard to protecting other stations (except each other) from interference when considered alone, shall be licensed without regard to extension of the coverage area of the primary station. If overall coverage is expanded without interference being produced to any other station, that is explicitly permitted.
(7) As synchronous boosters may have intentionally limited power and coverage areas, no minimum antenna efficiency, height or ground system requirements shall apply to them.
(8) A synchronous system of transmitters (i.e., a master station and its set of boosters) shall count as one station for the purposes of ownership rules, license renewal, and transfers.

The aforementioned synchronous-booster system could be of significant benefit to Class-C and -D stations with limited nighttime coverage, as well as other stations (mostly Class-B) with deep nighttime directional-antenna nulls. All these stations could greatly benefit from the improved population coverage at night and during critical hours, particularly where urban/suburban sprawl has expanded beyond the stations' existing strong-signal zones. Unlike FM translators, such on-channel boosters would serve to increase the AM stations' audiences while concurrently maintaining the future viability of the band. A typical example of the benefit of such can be illustrated in the Tri-Cities metropolitan area of upper East Tennessee/southwest Virginia, which consists of three principal communities (Johnson City, Kingsport, and Bristol) of roughly 50,000 population each, mutually separated by about 25 miles. Each small city has nighttime AM, either Class-C and -D and/or acutely limited Class-B stations which send main nighttime lobes away from the other cities in the metro; as a result, there is no universal nighttime local AM signal for the area. The use of synchronous boosters could clearly provide new, productive nighttime AM signals into each community from the local area, at very low cost to the stations involved and with significant public benefit. Further, these and other such synchronous boosters could well prove to be an economic boon to many struggling AM operations by permitting tailored coverage areas to match listening locales.

It is useful to examine how the phases/delays of the audio and RF components of the AM radio signals can affect reception quality in the field, particularly in signal-overlap regions. For instance, the RF signal delay is very roughly 1 millisecond for 186 miles (corresponding to the speed of light in air). At a point equidistant from two omnidirectional, co-phased (synchronous) transmitters with equal power and propagating via groundwave mode over land paths of identical RF conductivity, the two RF signals will arrive with equal amplitudes and delays (phases). Now if we assume that the RF carriers and the sideband audio signals are precisely in phase (matched in time) as they leave the two antennas, at the exact midpoint between the two transmitters the RF signals and the detected audio will also be in phase; the signals can be added algebraically to calculate the resultant. Now for points *not* equidistant from the two transmitters, the RF signals will vectorially add; in general, there will be augmentations and cancellations of the two waves occurring at spatial intervals of one-half wavelength, essentially the same as is the case for standing waves on a mismatched transmission line. Modulation distortion will be minimal near the 0°-additive points and rise somewhat at quadrature-phase contours, and peak as the summed signal approaches null at the 180° points. Obviously, near the equal-signal points, the standing wave patterns will exhibit maximum variations; in fact, **§**73.182(t) of the Commission's Rules defines the region of "satisfactory service" for synchronous stations as areas where the ratio of field strengths is ≥ 6 dB (≥ 2:1). However, the Rules as quoted did not assume the accurate time-synchronization of both audio components; as cited by Blanco-Pi and dLR, the audio time-matching significantly mitigates the apparent distortion and reduces the area of discernible distortion. The interference patterning in the synchronous overlap zone can be further reduced by phase-dithering of the booster signal(s), either in a cyclic or random-phase fashion. Terrain variations, buildings, and other groundwave scatterers or diffractors (i.e., multipath sources) will also reduce the magnitude of these overlap-zone disturbances via the inherent dithering of carrier phase. In moving vehicles, the audible effects will be even less, especially on speech programming. It has been long known [4] that the distortion zones can be designed to fall over less-populated areas and major arteries; in the Tri-Cities example above, for instance, the overlap zones (near 1:1 signal ratios) would obviously be configured to fall in the more rural areas between the three cities. Further, U.S. Patent 7,881,416 describes the further reduction of these standing-wave patterns (and distortion) with the use of additional low-power localized boosters in or near the equal-signal zones. The net result of all this is that synchronized AM boosters are indeed ready for immediate wide-scale deployment.

<u>Further Proposal 4</u> – Mandate Regional/National Synchronization of All AM Stations

Three papers, published by the IEEE and NAB in the 2007-2010 time frame, [2], [3], [4], and four U.S. Patents to Oak Ridge National Laboratory (ORNL), [5], described a straightforward but highly accurate carrier-frequency synchronization scheme for actively, automatically locking multiple, remotely located AM broadcast transmitters to a common frequency/timing reference source such as GPS. The extremely tight frequency lock (to ~1 part in 10^9 or better) permits the effective elimination of audible and even sub-audible beats between the local (desired) station's carrier signal and the distant stations' carriers. Generally, an AM radio listener during the evening and nighttime hours, and to a lesser extent in the early morning, receives undesired skywave signals from several distant co-channel stations as well as the desired local (groundwave) signal. These carrier-beat components in the current (non-synchronized) scenario can cause annoying modulations of the desired station's audio at the receiver and concurrent distortion of the audio modulation from the distant station(s) and often cause listeners to "tune out" due to the poor reception quality. This is quite understandable since the average carrier power is on the order of 10 dB above that of the typical levels of the sideband modulation components, and the inter-carrier beats will dominate the receiver's AGC and thus modulate the audio level. Along with EMI, these beat-related effects are certainly ***a*** (if not ***the***) principal factor in the degradation of evening and nighttime AM fringe-area reception quality and the resulting loss of outlying listeners for virtually *all* AM stations. Perhaps the most deleterious aspect of these beats is the listener-annoyance factor, in that the high-level artifacts (volume modulation, cyclic distortion, and pronounced swishing sounds) often quickly induce listener tune-outs. This situation is not only progressively worse further into the fringe areas of the desired stations (usually in the outer suburbs of the city of license), but also occurs much closer in, in the deep nighttime nulls of directional stations. The current poor state of repair of many AM directional arrays, plus the low-power pre-sunrise/post-sunset (PSRA/PSSA) operations at many Class-D stations, only exacerbates these problems.

If, however, we employ carrier synchronization, all of these signals' frequencies can be held to within about 0.01-0.001 Hz of each other, and any resulting carrier beats will be of such long periods that the beats will be effectively suppressed by the action of the receiver’s AGC circuitry and become completely unnoticeable to the listener. The significant reduction or elimination of the beats and related effects achievable via synchronization will greatly enlarge the effective *co-channel interference-limited* listening area of the desired station (from 4 to 10 times as indicated in our tests, dependent on program material) and simultaneously reduce the corresponding interference of the local transmitter to the distant stations as well. In addition, AM stereo (CQUAM) reception will be particularly improved by minimizing the phase shifts induced by co-channel interfering signals; HD signals will also benefit via reduction in beats from co-channel analog signals.

The automatic frequency-control hardware described in the references is inexpensive, requires no periodic recalibration, has essentially zero long-term drift, and could employ alternate wide-area frequency references of suitable accuracy, including broadcasts from WWVB, LORAN-C, and equivalent sources. The basic configuration of a commercially available GPS-disciplined oscillator which solves this problem is extremely simple and costs under $300 (including the GPS antenna). The main oscillator is a conventional high-stability ovenized quartz-crystal type. To counter long-term drifts, the oscillator is automatically adjusted to track a high-precision source of standard frequency obtained from a specialized GPS receiver (or other source), usually at 10.000 MHz. This very stable local reference frequency is then used as a clock for a standard digitally implemented frequency synthesizer, which is programmed to generate the specific (AM broadcast) transmitter carrier frequency desired. The stability of the disciplining source, typically ~ 1 part in 10^9 to 10^{11}, is thus transferred to the final AM transmitter carrier output frequency. Most modern, synthesizer-based transmitters can directly lock to the precision disciplined 10-MHz source, while older units usually require references at either 1×, 2×, or 4× the final frequency. In these latter cases, the existing transmitter crystal can usually be satisfactorily "pulled" via injection locking.

The effectiveness of the synchronization concept to reduce interference effects was demonstrated by ORNL researchers in a laboratory test setup, as described in the references above. Many hours of careful subjective listening were conducted, with the two interfering units both precisely on-frequency with the main unit (synchronous operation) and with the two interferers at various frequency offsets, from below 1 Hz to above 10 Hz. The most audibly annoying beats were generally judged to be below roughly 2 Hz, so several tests were conducted with offsets of 0.7 and 1.7 Hz, respectively, which tend to more closely emulate current AM channel beat characteristics. Subjective measurements to determine the familiar audible interference assessment criteria of "imperceptible", "perceptible", "annoying", and "objectionable" were made and documented. Overall, the net effect to the listener of synchronizing the AM carriers and thereby eliminating the beats is on average about 6 dB minimum and can often be as great as 10 dB; this is of major importance in evening, nighttime, and pre-sunrise situations where the SIR due to incoming skywave signals can degrade to levels of 12 dB or worse. From the standard propagation data, at the nominal fringe signal level of 0.5 mV/m (for all Classes of stations except A, defined as 0.1 mV/m), the daytime, groundwave co-channel signals (re **§**73.182) must each be no more than $^{1}/_{20}$ the amplitude (−26 dB) at the stated field-strength contour [or 25µv/m, (5µv/m for A)]. The same corresponding nighttime values of acceptable co-channel interference levels (−26 dB) are specified for Class A, 0.5 mV/m (50% skywave) contours and the 2 mV/m contours for Class B (groundwave). Allowing for finite ground conductivities, it is evident that an improvement of 6 dB in effective co-channel levels will ***nearly double*** the interference-limited contours of the stations compared with the standard, non-synchronous case (<u>*almost quadrupling the equivalent coverage area*</u>). As will be described later, our simulations with real broadcast audio demonstrated that for some types of programming (i.e., with good masking properties) the effective improvement can even approach 10 dB, which could nearly triple the interference-limited coverage range! With the beats eliminated, the background audio from the co-channel stations will be clean; often, the so-called "cocktail party" effect will reduce the apparent level of those signals to the listener even further, especially in high-background ambients such as automobiles. The net result of these effects will be universally evident but particularly beneficial to nighttime operations at local Class-C and Class-D stations, whose coverage areas are already acutely curtailed by heavy co-channel skywave interference. For these latter classes, the near-quadrupling of equivalent coverage at night should be a major benefit, particularly to listeners in outlying suburban areas.

The principal drawback to the approach is a practical implementation issue **–** ***all stations on the channel in question (at least those with signals above the noise floor at the receiver) must be closely frequency-locked to a common precise reference as just described, or the beats will not be eliminated. It is therefore incumbent on the Commission to mandate the wide-area synchronization requirement for all AM stations as soon as practicable.*** In our view, wide-area AM transmitter synchronization is (and at very low cost) the only technology that, when adopted, will <u>immediately</u> benefit *all* stations, *all* frequencies, and *all* receivers, both day *and* night.

<u>Further Proposal 5</u> – Allow No Applications for New AM Stations and Have No More Filing Windows for Short Form Applications

In agreement with Comments from dLR, Sellmeyer, H&D, and others, we believe that AM-band allocations have reached full maturity; it therefore makes no sense to consider adding new AM stations, except in a very few special cases (underserved, low-population or isolated areas). Existing AM stations should be strongly encouraged to improve their service to their actual audiences, with more flexibility in choosing their transmitter site locations and details of their technical facilities. We also firmly agree with dLR in the "use it or lose it" principle – if broadcasters refuse to upgrade, other stations should be permitted to make improvements subject to agreements submitted to the Commission for that purpose. Also, clearly speculative and all Short-Form applications should be screened and immediately required to be substantiated or be dismissed. To quote dLR's concise Comments on the matter:

> *"Much harm has been done to the prospects for improving AM stations in recent years because filing windows were held to allow in short-form applications for new stations and major changes that effectively blocked improvement possibilities for existing stations for years because of the need to protect the new short-form applications based on their assumed facilities. This should never happen again".*

We in general believe that the Commission's chief interest, besides implementing the first four Further Proposals above, should lie in pushing AM owners to repair and upgrade existing facilities to provide the full licensed level of service (largely measured by RF field contours and correct directional [horizontal *and* vertical] coverage patterns). Those owners who ***cannot*** or ***will not*** provide appropriate licensed service values should be persuaded to sell to others who will.

Further Proposal 6 – Defer any Changes to the Requirements for Protection of Existing Stations to Current Contour Levels, Day and Night

Numerous Commenters, especially those in the engineering community, have proposed several substantive changes to the Commission's Rules for co-channel protection of standard contours on virtually all classes of stations, based on the overriding assumption that neither the levels of RFI nor average AM receiver performance will ever improve. Given these assumptions, the arguments presented are logical, but we fundamentally disagree with that thesis. For the foreseeable future, we strongly encourage the Commission to defer any such irreversible allocation actions until all four of the initial measures we have proposed (q.v.) have truly had sufficient time to work. If these protection limits *are* reduced, there will be no later chance of ever recouping the lost coverage areas — the zones previously denied by noise will simply now be squashed by added co-channel (and adjacent-channel) interference from other stations.

Further, the immediate benefits of wide-area synchronization will additionally reduce the effective co-channel beat-induced interference by 6-10 dB and thus provide instant expansion of the fringe coverage area; as the EMI/RFI from Utility power lines, telephone bundles, and cable trunks are rapidly (or gradually) brought into Part-15 compliance, these gains will become fully evident to the AM listening public.

Further Proposal 7 – Revert to Nighttime RSS 50% Exclusion Rule

We agree with dLR, Sellmeyer, H&D, and others believe that nighttime protection should be based on protected-station RSS calculations using the traditional 50% exclusion principle, This method was in universally accepted use for many years before the adoption of the “Ratchet Clause,” which we urge should now be eliminated. We also believe that the 50% exclusion method was firmly based on valid statistical principles that accurately account for the highly variable nature of multiple interfering skywave signals arriving from different directions, each measured in terms of its individual value that is exceeded on average 10% of the time. The present reliance on 25% exclusion associated with the “Ratchet Clause” should be deleted, and the nighttime RSS interference standard should revert to the former 50-percent exclusion method.

<u>Further Proposal 7</u> – Standardize on Site-to-Site Nighttime RSS Limit Calculations

We agree in general with most of the engineering community that calculation of nighttime interference protection for Class B and Class C stations should be standardized to normally use only site-to-site RSS calculations, as it is the consensus methodology. This will simplify the overall processing of change applications for nighttime facilities. We can conceive of the need for "clipping" studies only in special situations when both significant RSS variations occur throughout the coverage area, and where major population centers are affected.

<u>Further Proposal 9</u> – Return to Former Method for Calculating Skywave Signal Long-Path Propagation to Domestic Stations

We believe, along with dLR and others, that the Rules should be quickly changed to specify the formerly-employed nighttime skywave model for calculations over paths between stations outside the Continental United States. The current nighttime skywave propagation model has been found to produce excessive values for certain long-path calculations – particularly for source stations outside the continental U.S. near the equator and over Pacific Ocean paths between Hawaii and the original 48 States. We agree that the Commission can best rectify this error by reverting to the former method that was in use for many years for propagation paths outside CONUS, until further detailed propagation studies can be implemented to correct the defective current latitude-dependent model.

<u>Further Proposal 10</u> – Enact Uniform Allocation Rules for Use in the Expanded Band

We agree with dLR, H&D, and others that the establishment of standardized allocation rules for use in the Expanded Band – the channel frequencies from 1610 through 1700 kHz – are timely. The original allocation guidelines stifle the opportunity for standard-band AM stations to voluntarily migrate to these frequencies and also restricts the flexibility of stations already there to make facility changes. As is, the Expanded Band is comparatively under-developed and should be seamlessly integrated with the rest of the AM service, including the adoption of a fully consistent set of allocation rules. It would also seem logical for the Commission to reclaim the 1610-kHz frequency from NTIA, move all the TIS stations to 530 kHz (with a concurrent RF power increase for them to overcome the higher levels of noise, both atmospheric and man-made, at that lower frequency). This would better serve the public by making TIS more consistent throughout the U.S. Also, TIS could be further utilized in emergency scenarios.

Another future possibility would be to introduce potential all-digital operational experiments into the Expanded Band, owing to the much-reduced level of impulse noise at those frequencies and the comparative lack of skywave interference versus the standard band.

Further Proposal 11 – Revise the Ground Conductivity Map to Better Reflect True Current Values

We believe, as several others have also asserted, that the 1954 standard R-3 Map, "Estimated Effective Ground Conductivity in the United States," significantly overestimates the actual ground conductivity in most cases and should be revised as soon as practicable, utilizing the large amount of more contemporary data filed with the Commission in the 60 years since it was originally adopted. This is particularly true in large urban and suburban areas, where land use changes have appreciably reduced the effective ground conductivity at AM frequencies. These errors also inhibit truly appropriate changes of facilities by obviously predicting more overlap between stations than is the actual case. We further have anecdotal evidence that field conductivity measurements have been conducted in several cases on rough and rolling terrain by taking readings at the tops of hills versus the intervening swales, and then choosing the values that yielded the most favorable results. Obviously, a spatial average would be more appropriate here, so an approved methodology should also be carefully specified with spot measurements to determine accurate average ground conductivity values in that area. We strongly recommend that the Commission engineering staff seriously study the detailed methodology proposed by dLR in their Further Proposal 16, at least as a first initial correction. It is clear that the overall effort to revise the R-3 chart may require some time, but it is key to the integrity of future engineering changes to AM facilities.

<u>Further Proposal 12</u> – Change the Method-of-Moments Directional Antenna Proof Rules to Simplify Measurements, Documentation, and Recertification Requirements

We fully agree with dLR and several other Commenters that a general streamlining of the Method-of-Moments (MoM) rules for directional antenna systems is clearly in order. The demonstrated reliability of these techniques, their long-term accurate correlation with standard field measurements, and their widespread general use in international broadcasting scenarios all attest to the efficacy and utility of these techniques. In general, MoM computer-based modeling can quickly reveal antenna and pattern shifts and in most cases avoid the much more tedious, time-consuming, and expensive process of taking accurate multipoint field measurements. The Commission technical staff should immediately begin collaborations with recognized consulting firms to develop expedited rules governing the use of MoM methodologies and simplifications to procedures, required documentation, field surveys, and recertification of systems typically used for directional antenna monitoring.

<u>Additional Proposals and Comments</u>

(1) Several commenters have suggested eliminating the existing NRSC 75-μs response curve for AM audio transmission. It should be remembered that this standard was largely an effort to avoid the huge boosts in high frequencies (up to 30 dB) that several audio-processor manufacturers were offering to broadcasters in the 1980s as a way of combating the horrendous rolloff of typical AM receivers; the result led to extreme sideband amplitudes at higher frequencies (even up to 15 kHz in some cases) and concurrently high levels of ACI. The NRSC standard was actually designed as a compromise solution to that problem using the well-known single time-constant preemphasis technique; the 10-kHz post-filtering was an accompanying function to reduce ACI (which it did). Obviously, no broadcaster should be forced to employ bandwidth in excess of programming needs and loudness considerations, but we agree with Sellmeyer Engineering that the curve be retained up to at least 6 kHz in all cases, and we assert that the present 10-kHz bandwidth should always remain an option.

(2) We strongly support further encouragement by the Commission of advanced transmitting antenna technology development, as others have already suggested, and we appreciate the Commission's past acceptance of our KinStar antenna as an example of such advances. We further fully agree with dLR, H&D, Sellmeyer, Dr. Marcus, and others, that parasitic elements be immediately permitted in AM directional arrays in the U.S. The application of advanced antenna and monitoring systems can greatly facilitate and simplify the ongoing maintenance of patterns, reduce interference, and lower costs to the stations. Finally, the search for workable anti-skywave antennas, only real solution for widely improved nighttime coverage, must continue in force.

(3) The use of synchronous broadcast methods, as described in Further Proposal 4 above, can support new, revenue-generating services for stations, including local-area radiolocation systems to augment GPS and like systems. In heavily urbanized or rough-terrain areas, where GPS signals are weak or impaired by multipath, AM signals could provide a useful adjunct to enhance locating-system reliability. The phase-stable carriers of such signals, with appropriate auxiliary data and proper averaging, could be used to cover locales with poor GPS signals to accuracies of typically 1% of the RF wavelength (~ ±3 m at 1 MHz) in open terrain, with somewhat lesser accuracy in heavily urbanized areas.

CONCLUSION

AM radio is a longstanding American institution, a source of unique voices, and one that we can ill afford to abandon, particularly in light of its unique **groundwave and nighttime skywave** propagation characteristics and tremendous reach, especially in times of local, regional, and even national emergencies***. During the recent national disasters, Hurricane Katrina and Hurricane Sandy, AM radio stations proved to be the news source that the public utilized more than any other when telecom and other services were unavailable. Truly, this AM Revitalization action has the rare potential of conserving a unique national resource.***

We believe that AM radio stations can be relied upon to provide needed service well into the future, but the Commission must take several bold steps in the very near future to preserve AM radio for future generations of Americans. KTL believes that the suggested actions can be undertaken rapidly to encourage a general revitalization of the AM radio service, and we strongly encourage the Commission to take them now. We reiterate our agreement in principle with most of the Further Comments and Reply Comments already offered by others in the consulting engineering community, though with some alternative suggestions. Our proposals are driven by our overriding view that the Commission must move forcefully to enforce Part 15 Unintentional Radiator rules on Utilities and others, and further mandate major improvements in AM receiver performance, especially to achieve near-parity with FM. Also included in our proposals to improve AM reception are the simplified adoption of synchronous booster stations to augment existing AM station coverage and the mandate of wide-area GPS-based synchronization to significantly reduce co-channel interference via the elimination of carrier beats. Without these high-level actions, many of the other suggestions for improving AM service will likely become moot unless the listening public is incentivized to return to the band, via the rapid establishment of noticeably better audio and reception conditions throughout the U.S.

Respectfully Submitted, March 19, 2014

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